Ultrafast lattice dynamics probed with time-resolved X-ray diffraction

Our group studies ultrafast lattice dynamics using time-resolved X-ray diffraction. Our experimental setups include a plasma X-ray source (PXS) which allows a temporal resolution of 150 femtoseconds and a synchrotron-based pump-probe setup, which employs a high-repetition-rate laser. The latter enables us to measure at the full repetition rate of the synchrotron of 1.25 MHz.
In our experiments, we induce strain waves in a material using the absorption of an optical pump pulse. X-ray probe pulses monitor the propagation of the resulting coherent strain waves on timescales up to one nanosecond. On longer timescales, the relaxation of the excited material is determined by heat diffusion from the excited layers into the substrate. Both mechanisms, coherent phonon decay and heat diffusion yield insights into phonon-phonon interactions in harmonic and anharmonic potentials. I will also discuss possible applications of coherent phonons in matter which may lead to an ultrafast switch for hard X-rays.